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(54) Title: IRRIGATION/ASPIRATION MANIFOLD AND FITTINGS FOR ULTRASONIC SURGICAL ASPIRA- TION SYSTEM <div style="text-align: center;"> </div> (57) Abstract <p>An ultrasonic surgical aspirator having an improved irrigation/aspiration manifold and components to facilitate quick connections of the irrigation and aspiration lines to a handpiece. In combination with a handle assembly (31) having an ultrasonic vibrator (32) for vibrating an ultrasonic tip (34) and a nosecone (33), a nosecone extension (42) defining a rotating joint (43) for connection to the nosecone in an articulating joint for connection to a rigid or flexible flue (47, 49). The nosecone extension further defines an irrigation cowl (77) having an irrigation port for receiving an irrigation connector (77) for connecting the irrigation fluid to the nosecone extension for passage of irrigation fluid through the nosecone extension and a flue about the surgical tip. An aspiration tubulation connector (71) adapted to securely fit a slot through the nosecone and nosecone extension connects an aspiration port (37) on the tip to the aspiration tube (76) for connection to a pump into a discard.</p>		

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1 IRRIGATION/ASPIRATION MANIFOLD AND
2 FITTINGS FOR ULTRASONIC SURGICAL ASPIRATION SYSTEM

3
4 Background of the Invention

5 This invention relates to an ultrasonic sur-
6 gical aspiration system. More particularly, this
7 invention relates to an improved irrigation/aspiration
8 manifold and associated parts for such an ultrasonic
9 surgical aspiration system. Still more particularly,
10 this invention relates to the use of mating connections
11 in such a system to allow easy, rapid, and foolproof
12 connections to the irrigation, aspiration, and tissue
13 relief ports in an ultrasonic surgical aspiration
14 system. In addition, this invention relates to an
15 improved transition member which allows an easy
16 exchange of flues, articulation without leakage, and a
17 swivel joint which permits use of curved ultrasonic
18 members in an ultrasonic surgical aspiration system.

19 Ultrasonic surgical devices are known for
20 performing a number of surgical procedures. A repre-
21 sentative device is shown in United States Patent No.
22 3,589,363 describing a hand-held instrument having an
23 operative tip vibrating at a frequency in the ultra-
24 sonic range, and in which a handpiece includes a trans-
25 ducer. Connections are provided on the handpiece to a
26 source of treatment fluid and to a pump to withdraw
27 suspended tissue particles in a fluid from an operative
28 site.

29 The design of such ultrasonic surgical
30 devices has depended not only on the technical and
31 functional requirements of a resonant body, but also
32 upon their surgical application. Thus, the parameters
33 of the system, the length of the tip, and the tip
34 stroke and diameter to be acceptable for a useful sur-
35 gical device in various operative site areas have
36 developed over the years, based upon experience with

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1 such devices. Attention has been paid in the art to
2 the development of the various components in the
3 system, with the result that an ultrasonic surgical
4 aspiration instrument is well-known and used as a
5 sophisticated high-technology surgical instrument.

6 Such a system has been developed and produced
7 by the assignee of this invention which comprises an
8 assembly of an acoustic vibrator, a nosecone, a flue, a
9 handpiece and a manifold. The assembled system pro-
10 vides a source of irrigation fluid to an operative site
11 and the aspiration of surgically-excised particles from
12 the site under the control of precise and sophisticated
13 instrumentation. A number of modifications to such a
14 basic system have been made with respect to such items
15 as the length and shape of the tip, its coupling with a
16 transducer, the use of an extender (whether curved or
17 straight), and others. Usually, the components for a
18 surgical use are provided as a part of a sterile sur-
19 gical kit to be used and discarded after each surgical
20 procedure.

21 The acoustic vibrator assembly includes the
22 combination of a transducer connected to a handpiece
23 for providing a source of ultrasonic vibrations to a
24 tip. When the tip is connected to the transducer, or
25 to a straight or curved extender interposed between the
26 tip and the transducer, provisions are made in the kit
27 for connecting the components to a predetermined level
28 of tightness. A nosecone assembly is then assembled
29 from a nosecone which is provided with O-ring seals in
30 grooves in the nosecone and slid over the acoustic
31 vibrator until seated. A flue is slid over the tip and
32 hand tightened to the nosecone to provide a passage
33 within the flue and about the length of the tip for
34 irrigation fluid from the nosecone to the tip. A nose-
35 cone adapter may be used with an extender flue to pro-
36 vide alternative length and shapes for the convenience

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1 of the surgeon and safety for the patient for parti-
2 cular operations. When used, the nosecone adapter is
3 tightened to the nosecone and the extender flue is
4 gently pushed over the tip of the nosecone so that the
5 curve of the extender and flue match without the flue
6 touching the tip. The body of the flue adapter is
7 twisted to centralize the tip within the flue. There-
8 after, the acoustic vibrator and the nosecone with the
9 flue attached are inserted into a handpiece housing and
10 seated so that the fluid manifold assembly may be com-
11 pleted.

12 An irrigation tube with a flexible applicator
13 cable is fed through a slot in the nosecone and through
14 an aspiration port on the exterior of the tip. By
15 gently pulling the cable through the port in the tip,
16 the aspiration tubing attaches to the aspiration port
17 on the tip. The other end of the aspiration tubing is
18 connected about a pump to control aspiration pressures
19 and to a discard region for discarding extracted
20 tissue. Metallic clips are provided to secure the
21 aspiration tubing to the exterior of the handpiece
22 housing. Thereafter, irrigation tubing is connected to
23 the irrigation port on the nosecone for connection at
24 its other end to a source of irrigation fluid, such as
25 an IV bottle. Additional clips are provided to the
26 handpiece cable to secure the manifold.

27 Thus, the assembled system is able to provide
28 irrigation fluid from an irrigation fluid source
29 through tubing to an irrigation port and through the
30 nosecone into the area intermediate the tip and the
31 flue to irrigate the surgical site adjacent the tip
32 extending from the flue. Aspiration occurs from the
33 operative site through an aspiration passage to the
34 aspiration port and through the aspiration tubing to
35 aspirate surgically-excised particles.

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1 As can be seen from the above simplified
2 description, several fluid connections must be made at
3 the surgical handpiece and elsewhere to provide irriga-
4 tion to and aspiration from the surgical site. While
5 such prior designs were satisfactory, they utilized
6 plain tubing ends which require skilled and special
7 application techniques for making the connections. In
8 addition, the assembly procedure was further compli-
9 cated by the number of tips and extended options avail-
10 able to the surgeon. It thus remained a problem in the
11 art to assure easy, rapid and fool-proof connection of
12 the irrigation, aspiration and tissue release ports to
13 the correct tubing and location, since such connections
14 are made in an operating room in preparation for sur-
15 gery or during the surgical procedure itself in certain
16 situations where modification or reconnection is
17 needed.

18 Thus, it is a main objective of this inven-
19 tion to provide a mating component system for an ultra-
20 sonic surgical vibrator which uses quick-connecting
21 devices to facilitate connection of the components and
22 tubing to the irrigation, aspiration and tissue release
23 ports.

24 It is another object of this invention to
25 provide an improved transition piece to permit an easy
26 exchange of flues between a rigid flue and a ribbed
27 flexible flue for easy connection to an assembly of a
28 handle, nosecone, and tip.

29 It is an additional object of this invention
30 to provide a nosecone extension which provides a rota-
31 ting joint for assembly to a nosecone and an articula-
32 ting joint for connection to either a rigid flue
33 secured with or without an O-ring or to a ribbed flex-
34 ible flue.

35 It is a further object of this invention to
36 provide a ribbed flexible flue structure for convenient

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1 use with an ultrasonic surgical aspiration system of
2 the type described.

3 It is a further object of this invention to
4 provide a nosecone extension adapter for ready connec-
5 tion to an extender connected to an assembly of a
6 handle, nosecone, and vibrator for receiving therein an
7 extended tip and an extender sheath which is connected
8 to the nosecone extension adapter for connection
9 between the extender sheath and a flue adapter having
10 an articulating joint for receiving either a ribbed
11 flexible flue or a rigid flue as described.

12 It is an additional object of this invention
13 to provide an aspiration tubulation connector for
14 secure connection to an aspiration tube and quick,
15 secure connection with limited motion to the aspiration
16 port on the tip within a confined space in the interior
17 of the handpiece.

18 It is a further object of this invention to
19 provide a quick connect fitting for connection between
20 an end of the irrigation tube and the irrigation tube
21 fitting by turning and locking, and easy connection to
22 an irrigation port on a transition member or nosecone
23 extender.

24 It is a more general object of this invention
25 to provide an ultrasonic surgical aspiration system
26 with conveniently-usable components capable of easy
27 assembly in diverse combinations while minimizing error
28 in the assembly, which components are adapted for easy
29 fluid connection.

30 These and other objects of the invention will
31 become apparent from the written description of the
32 invention which follows.

33 Brief Summary of the Invention

34 Directed to achieving the foregoing objects
35 and to overcoming problems in the art, in one aspect,
36 the invention relates to a nosecone extension member

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1 defining at its inlet end a rotating joint for secure
2 connection to a nosecone in an ultrasonic surgical
3 system, and an articulating joint at its outlet end for
4 connection to either an articulated rigid flue having
5 an O-ring seal to prevent leakage, or to a ribbed flex-
6 ible flue for use with curved tip members. The rigid
7 flue is preferably optically transparent, having a
8 tapered body defined in cross-section by an annular
9 wall terminating at its connecting end in an arcuate
10 seal portion to receive therein an O-ring for connec-
11 tion to the articulating joint on the nosecone exten-
12 sion or on a flue adapter connected to an extender
13 sheath connected to a nosecone extension adapter. Such
14 a construction permits the rigid flue to be articulated
15 relative to the articulated joint to center the tip
16 intermediate therein in a rigid yet leak-proof
17 manner. The flexible flue includes a plurality of
18 spaced interior ribs in a similar construction extend-
19 ing in the interior of the body thereof. The connect-
20 ing end of the flexible flue defines a diameter greater
21 than the diameter of the flexible flue near its
22 connecting end and angularly merging with the flue
23 body.

24 The nosecone extension defines an articula-
25 ting joint at one end thereof as having a recess for
26 receiving an O-ring seal at said joint. The nosecone
27 extension is defined by a body defining a passage
28 therein through which passage the ultrasonically-
29 vibrated tip passes. The passage includes an inwardly
30 turned radius at one end thereof for securing the nose-
31 cone extension to the nosecone with a snapping action,
32 while permitting rotation of the nosecone extension
33 about the nosecone. The nosecone extension further
34 defines an irrigation fluid passage merging with the
35 tip passage in the nosecone toward its forward end and
36 emerging as an irrigation cowl from the body of the

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1 nosecone extension near its inlet end for receiving
2 therein an irrigation fitting for easy connection to
3 irrigation tubing. Such a nosecone extension structure
4 facilitates ready and easy connection of a flue
5 (whether flexible or rigid) with an O-ring seal at the
6 forward end thereof for articulation relative to the
7 protruding tip through the nosecone extension, easy
8 rotatable mating connection with a mating structure on
9 the nosecone, and an irrigation connecting port for
10 ready connection of the irrigation tubing with an irri-
11 gation fitting. Preferably, the nosecone extension or
12 transition piece snaps onto the nosecone while allowing
13 rotation of the irrigation port relative to the
14 resonator of the handpiece for convenience of instal-
15 lation.

16 The irrigation fitting according to the
17 invention comprises a tapered length of tubing defining
18 a first portion angularly bent relative to the remain-
19 ing portion, a central radially-extending rib for
20 limiting insertion of the tapered end into the irriga-
21 tion port on the nosecone extension and a barbed
22 exterior end over which irrigation tubing may be
23 securely slip fit while resisting withdrawal
24 therefrom. Such a fitting easily cooperates with the
25 irrigation port on the nosecone irrigation cowl to
26 facilitate connection and location of the irrigation
27 tubing.

28 According to another aspect of the invention,
29 for use in an assembly of a tip/nosecone/handle sub-
30 assembly secured at its forward end to an extender for
31 housing an extended tip, a nosecone extension adapter,
32 which is shaped similarly to the nosecone extension
33 previously described, is provided having a rotating
34 joint for connection to the nosecone and a forwardly
35 extending member having an outwardly turned forwardmost
36 portion for securing thereon an extender sheath. In

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1 this combination, a flue adapter defining at its for-
2 ward end an articulating joint and at its aft end a
3 tube and seal arrangement receives either the rigid
4 flue or the ribbed flexible flue as previously
5 described.

6 In another aspect of the invention, an aspir-
7 ation tubulation connector is provided for quickly
8 connecting the aspiration tubing securely at one end
9 thereof to an inward port and is connected at its out-
10 ward port to the aspiration port on the cutting tip
11 through a rotating movement through a slot in the nose-
12 cone subassembly. The axis of connection of the aspir-
13 ation tubing after the tubulation connector is secured
14 lies parallel to the axis of connection of the outward
15 port so that the tubulation connector defines a portion
16 lying on the surface at the exterior of the nosecone
17 and a portion fitted into the slot in the nosecone.
18 This fitting in addition provides a non collapsable key
19 for aspiration connection.

20 In still another aspect of the invention, the
21 aspiration tubing is connected to a T-valve assembly at
22 a location intermediate the handpiece and a pinch valve
23 and vacuum cannister for connection with a duckbill
24 valve vent fitting.

25 These and other features of the components of
26 the assembly and of the assembly itself will become
27 further apparent from the detailed written description
28 of the invention which follow, taken in conjunction
29 with the drawings.

30 Brief Description of the Drawings

31 In the drawings:

32 Fig. 1 is a diagrammatic assembly drawing of
33 the handpiece components of a known ultrasonic surgical
34 aspiration system;

35 Fig. 2 is an assembly diagram similar to Fig.
36 1 modified according to the invention to include a

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1 nosecone extension with an irrigation cowl adapted for
2 an articulating connection with either a rigid flue or
3 a ribbed flexible flue and a rotating connection to the
4 nosecone;

5 Fig. 3 is a diagrammatic assembly drawing of
6 the components of a modified ultrasonic system using an
7 extender with an extender sheath and extender tip, and
8 illustrating a nosecone extension adapter and flue
9 adapter according to the invention, the former defining
10 an irrigation cowl and a rotating connector with the
11 nosecone, the latter articulatingly connecting either a
12 ribbed flexible flue or a rigid flue;

13 Figs. 4A and 4B together show the use of an
14 aspirator tubulation connector according to the inven-
15 tion for quickly connecting aspiration tubing to an
16 aspiration port within the nosecone through minimum
17 rotation;

18 Fig. 5 illustrates the assembled handpiece
19 having the components shown in Fig. 2 and illustrating
20 the improved connectors for the aspiration tube, the
21 irrigation tube, and to the tissue release port on a
22 panel of a control instrument;

23 Fig. 6 is a side cross-sectional view of a
24 nosecone used in the assemblies of Figs. 1-5 to which
25 either a nosecone extension or nosecone extension adap-
26 ter according to the invention is connected;

27 Fig. 7 is a side cross-sectional view of an
28 articulated rigid flue to provide an articulating con-
29 nection to the articulating joint on the nosecone
30 extension or the flue adapter according to the
31 invention;

32 Fig. 8 is a side cross-sectional view of a
33 ribbed flexible connector according to the invention
34 for connection to either the nosecone extension or the
35 flue adapter according to the invention for providing
36 an articulating mounting suitable for curved tip
37 members;

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1 Fig. 9 is a side cross-sectional view taken
2 along line 9-9 of Fig. 8 near the exit port of the
3 flexible flue;

4 Fig. 10 is a side cross-sectional view taken
5 along line 10-10 of Fig. 8 near the entry port of the
6 flexible flue;

7 Fig. 11 is a side plan view of a nosecone
8 extension used in the embodiment of Fig. 2 to connect
9 either flue embodiment to the nosecone;

10 Fig. 12 is a cross-sectional view taken along
11 line 12-12 of Fig. 11 and rotated through ninety
12 degrees to illustrate the irrigation cowl and tubing
13 port for receiving the irrigation tubulation connector;

14 Fig. 13 is a cross-sectional view of Detail
15 13 taken as shown in Fig. 12.

16 Fig. 14 is an end view taken from the exit
17 end of Fig. 12 showing the articulating joint of the
18 nosecone extension according to the invention.

19 Fig. 15 is an end view taken from the end of
20 the nosecone extension opposite to that shown in Fig.
21 14 and further illustrating entry of the irrigation
22 port into the tip passage defined by the nosecone
23 extension according to the invention;

24 Fig. 16 is a side cross-sectional view of a
25 nosecone extension adapter having a rotating connecting
26 end for use in the embodiment of Fig. 3 for connecting
27 an extender sheath at its outboard port and connection
28 to the nosecone at its inboard port in the embodiment
29 of Fig. 3 using a tip and curved extender with an
30 extender sheath;

31 Fig. 17 is a cross-sectional view of Detail
32 17 at the outboard port of the nosecone extension
33 adapter according to the invention;

34 Fig. 18 is a side cross-sectional view of a
35 flue adapter for use in the embodiment of Fig. 3 for
36 connection at its inboard port to the extender sheath

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1 and having an articulating joint at its outboard port
2 for connection to either flue embodiment;

3 Fig. 19 is a cross-sectional view of Detail
4 19 shown in Fig. 18;

5 Fig. 20 is a plan view of the flue adapter
6 according to the invention from which the cross-section
7 of Fig. 18 is taken;

8 Fig. 21 is an end view of the flue adapter
9 shown in Figs. 18-20 showing its internal centering
10 rib;

11 Fig. 22 is a side cross-sectional view of the
12 construction of the irrigation fitting shown in Fig. 5
13 for insertion into the nosecone extension of Figs. 11-
14 15 on the nosecone extension adapter of Fig. 16;

15 Fig. 23 is a side plan view of the irrigation
16 fitting showing its contour and bend after turning when
17 in place;

18 Fig. 24 illustrates a plan view of the aspir-
19 ation tubulation connector according to the invention;

20 Fig. 25, comprising Figs. 25A, 25B, 25C, 25D
21 and 25F together, illustrates the left side portion of
22 the aspirator tubulation connector respectively showing
23 a plan view, a left end view, a right end view, a top
24 view, and a bottom view of the left side of the
25 aspirator tubulation connector;

26 Fig. 26 is a view taken along detail 26 of
27 Fig. 25 showing seal detail;

28 Fig. 27, comprising Figs. 27A, 27B, 27C, 27D,
29 and 27E together, respectively illustrates the right
30 side of the aspirator tubular connector and respec-
31 tively shows a plan view, a left side view, a right
32 side view, a top view, and a bottom view; and

33 Fig. 28 is a cross-sectional view of the seal
34 used for connection to the vacuum port on the panel of
35 an instrument for controlling one of the system param-
36 eters.

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Detailed Description of the Preferred Embodiment

Fig. 1 illustrates components of a handpiece of a known ultrasonic surgical aspirator system designated generally by the reference numeral 30. The system 30 includes a handle assembly 31 connected to an ultrasonic transducer and vibrator 32, a nosecone 33 and an ultrasonically-vibrated surgical tip 34. The combination of the vibrator 32 and the tip 34 comprises an acoustic vibrator assembly for vibrating the tip for surgical excision at a frequency in the ultrasonic range. The tip 34 defines an acoustic coupling surface 35 forward of a threaded connection 36 and terminates at its aft end in an aspiration port 37, in a manner known to the art. The vibrator 32 defines an internally threaded female threaded portion 38 for mating with the threaded portion 36 of the tip 34. When so threadedly engaged, the aspiration port 37 is located within a chamber 39 defined in the vibrator 32 which is accessed through a slot 40. The nosecone 33 also defines a slot 41 which when threaded to the handle assembly lies in axial alignment and in register with the slot 40. The nosecone 33 is threaded onto an external threads 45 on a threaded portion of the handle assembly 31. Such assemblies are known to the art for their intended purpose.

The procedure for connecting the irrigation and aspiration tubing lines to the assembly 30 in Fig. 1 has been described generally in the background of the invention. It should be understood that when the components are fully assembled, the tip 34 defines an annular space at the outlet of the vibrator 32 through the nosecone 33 for conducting irrigation fluid from a fluid source to the surgical site at the distal portion of the tip 34. In addition, aspiration tubing is connected to the aspiration port 37 through the aligned slots 41 and 40 as previously described. It should be

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1 further understood that power is supplied to the unit
2 from a console which otherwise controls the parameters
3 of the surgery, including vacuum at a suction port at
4 the face of the unit for controlling the aspiration
5 rate through the aspiration tubing. The irrigation
6 tubing is connected to a source of irrigation fluid
7 located at a predetermined height relative to the sur-
8 gical site and the manner of use of such instrument in
9 a number of surgical procedures using a console of the
10 type generally described is well-known in the art.
11 Accordingly, the aspects of this invention which relate
12 to its mechanical connections among the various compo-
13 nent parts and of the several pieces of tubing forming
14 the completed unit can be abbreviated.

15 Figure 2 illustrates the assembly 30 of Fig.
16 1 in its assembled state. A nosecone 33 is shown in
17 greater detail in Fig. 6 to provide a basis for under-
18 standing the connection of a nosecone extension 42
19 according to the invention. Throughout this specifi-
20 cation the inward, inboard, or inlet side of a
21 component refers to the portion of the component nearer
22 to the handpiece assembly 30, whereas the outward,
23 outboard, or outlet side of the component refers to the
24 side nearer the surgical site and operative tip 34.

25 Thus in summary, the nosecone extension 42
26 provides at its inward side a rotating joint 43 which
27 permits the nosecone extension 42 to be snapped on to
28 the nosecone 33 as will be described in greater
29 detail. The extension 42 also defines an outward
30 articulating joint 44 for receiving either a rigid flue
31 47, shown in Fig. 7, or a flexible flue 49, shown and
32 described in connection with Figs. 8-10. The articu-
33 lating joint 44 permits easy insertion of either flue
34 embodiment in an articulated fashion to permit adjust-
35 ment of the tip centrally of the bore of either flue,
36 and with a leakproof arrangement. Accordingly, the

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1 articulating joint 44 may be connected to the inward
2 end 46 of the rigid flue 47 or the inward end 48 of the
3 ribbed flexible flue 49. When the rigid flue 47 is
4 used, an O-ring 50 is mounted in an O-ring recess 51 in
5 the articulating joint 44 to provide a seal to prevent
6 leakage at that connection.

7 The development of convenient alternative
8 components has produced the representative alternative
9 embodiment shown in the assembly designated generally
10 by the reference numeral 55 in Fig. 3. That assembly
11 uses an extended tip 54a which is curved as is an
12 extender 56 which together are connected to the hand-
13 piece assembly 30 generally in the manner described. A
14 nosecone extension adapter 57 is shown in greater
15 detail in Figs. 16 and 17 to define at its inward end a
16 rotating joint 58 to be secured to a snap ring assembly
17 59a on the outboard or outward end of the nosecone 33
18 in the handpiece assembly 30. The outward end 59 of
19 the nosecone extension adapter 57 is structurally sized
20 and adapted to receive an inward end 62 of a curved
21 extender sheath 60 in a slip fit arrangement thereon.
22 A flue adapter 61, shown in greater detail in Figs. 18-
23 21, defines at its inward end 68 a cylindrical member
24 67 having an outwardly flared portion 69 for securing
25 the flue adapter 61 within the wall at the outward end
26 66 of the extender sheath 60. The outward end 70 of
27 the flue adapter 61 defines an articulating joint 70
28 similar to the articulating joint 44 on the nosecone
29 extension 42 in Fig. 2 for receiving a ribbed flexible
30 flue 49 or a rigid flue 47 in the same manner as
31 referred to above. The ribbed flexible flue 49 may be
32 conveniently used instead of the rigid flue 47 for
33 curved members such as the tip 54A and the extender 56.

34 An important feature of the invention, as
35 best seen in Figs. 4A and 4B and in detail in Figs. 24-
36 26, involves the use of an aspiration tubulation

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1 connector 71 for connecting the aspiration tubing 76 to
2 the aspiration port 37 on the tip 34 within the chamber
3 39 on the interior of the assembly 30. With the orien-
4 tation shown in Fig. 4A, the slots 40, 41 lie in the
5 upper portion of the sketches to show the aspiration
6 tubulation connector 71 which has an outer body portion
7 72 rigidly secured to the aspiration tubing 76 and a
8 transition portion 74 defining an outward port 75
9 inserted in the slots 40, 41 ready for mating of the
10 outward port 75 with the port 37 of the tip 34. Fig.
11 4B shows the positioning of the aspirator tubulation
12 connector 71 after the connection is manually made
13 wherein the outer body portion 72 lies along the wall
14 of the nosecone extension 42 and includes a seating
15 portion 73 seated in the slots 40, 41. The body
16 portion 72 is shaped to receive the fingers of the
17 assembler in a convenient fashion, while the seating
18 portion 73 is sized to provide a tactile indication
19 that the outward port 75 has properly engaged the port
20 37. The details of the aspiration tubulation connector
21 will be described and seen later in connection with
22 Figs. 24-27. Accordingly, the use of the aspiration
23 tubulation connector 71 according to the invention
24 provides a quick, convenient and fool-proof method for
25 connecting the aspiration tube 76 to the aspiration
26 port 37 and avoids the manipulative difficulty
27 associated with the threading of a cable connected to
28 the aspiration tubing through the aspiration port in
29 the tip after insertion through the slot 41 as in the
30 prior art embodiment. Thus, the connector 71 defines
31 an aspiration passage through the wall of the handpiece
32 assembly 31.

33 As shown in Figs. 4A and 5, after connecting
34 the connector 71 as described, the aspiration tube 76
35 lies along the body of the handle assembly 31 and is
36 secured thereon by resilient bands 76A similar to the

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1 current manner. Because of the rigid or elastomeric
2 structural connection, a fluid tight connection is
3 assured in spite of manipulations of the handpiece
4 during the surgical procedure.

5 As also shown in general in Fig. 5, the nose-
6 cone extension 42 includes an outwardly extending irri-
7 gation cowl or housing 77 for receiving an irrigation
8 fitting 78, described in greater detail in connection
9 with Figs. 22 and 23. An irrigation fitting 78 is
10 inserted in the irrigation housing 77 on the nosecone
11 extension or transition 42 which, upon a certain turn
12 and lock arrangement, secures an irrigation tube 39 to
13 the assembled handpiece 31. The other end of the irri-
14 gation tube 89 is connected, as is known, to a hanging
15 bottle of irrigation solution.

16 Fig. 5 shows a further feature of the
17 assembly according to the invention involving the use
18 of a seal 94 connected to the aspiration tube 76 having
19 therein a duckbill valve connected to a tissue release
20 port on the front panel of a control unit (not
21 shown). Thus, a simple T-valve assembly with seal is
22 defined while the other end of the aspiration tube 76
23 is connected to a pinch valve on the control console
24 for controlling aspiration, and to a vacuum canister
25 (not shown) for receiving the discharged aspirated
26 particles.

27 The assembly of components as described in
28 connection with Figs. 1 through 5 makes simple the
29 connections necessary at the surgical handpiece 31 and
30 elsewhere to bring irrigation to and aspiration from
31 the surgical site. Those components and their assembly
32 avoid the use of plain tubing ends which required
33 skilled special application techniques as described,
34 for making the connections, while providing quick
35 connect devices which allow easy, rapid and fool-proof
36 connection of the irrigation, aspiration, and tissue

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1 release ports during setup of the instrument for
2 surgery. The improved transition piece, or nosecone
3 extension 42 on the handpiece 31 further permits an
4 easy exchange of flues between the rigid and flexible
5 embodiments, as may be necessitated or desired during
6 surgery and their articulation for the convenience of
7 the surgeon and to assure smooth even flow of irriga-
8 tion fluid together with a swivel joint which permits
9 the use of curved ultrasonic tips, whether of normal
10 length or extended.

11 In order to provide the basis for under-
12 standing in greater detail the assembly according to
13 Figs. 2-5, a cross-section of the nosecone 33 is shown
14 in Fig. 6. The nosecone 33 defines a generally cylin-
15 drical wall-portion 101 having a circular cross-section
16 defining a plurality of stepped chambers 102 on the
17 inward side thereof and terminating in a snap-ring
18 recess 103 which merges into a tapered forward portion
19 104 at the forward end thereof. The slot 41 in the
20 nosecone 33 is defined in the wall 101 in the forward-
21 most portion of the nosecone 33. A chamber 105 is
22 defined interiorly of the slot 41, while one of the
23 stepped chambers 102 defines an interior thread for
24 threaded engagement with mating threads 45 on the
25 handle assembly 31. Preferably, a pair of opposed
26 slots 41 are provided.

27 The tapered forward end 104 and the recess
28 103 are sized and arranged to receive conveniently and
29 securely the rotating joint 43 on the nosecone
30 extension 42, as described in connection with Fig. 2.

31 At the outward end of the nosecone extension
32 42, either of a pair of flue embodiments 47 and 49 are
33 located to define the irrigation fluid passage. Thus,
34 in Fig. 7, a rigid articulated flue 47 is shown in
35 cross-section as defined by an elongated, tapered
36 member 110,, preferably made from plastic, and defining

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1 an axially elongated bore 111 therein. At its outer-
2 most end 112, the bore 111 defines a cross-sectional
3 area sufficient to permit the distal end of the tip 34
4 to pass therethrough, while defining an annulus between
5 the tip end and the wall 112 for the passage of irriga-
6 tion fluid therethrough to the surgical site. Prefer-
7 ably, the taper of the interior wall is on the order of
8 about 3 degrees while the taper of the exterior wall is
9 on the order of about 4 degrees so that the wall
10 gradually thickens towards its inward end 113. On the
11 interior portions of the inward end 113 are defined a
12 pair of arcuate recesses 114 forming portions of the
13 diameter of a circle and sized to be securely but rota-
14 tionally received on the articulating joint 44 of the
15 nosecone extension 42. The center of the circle
16 defining the surfaces 114 lies outwardly from the hand-
17 piece and, within the body of the unit so that the
18 minimum wall thickness lies inwardly from the end
19 113. Such an overlapped construction permits a snap
20 fit of the articulated flue onto the articulated joint
21 to facilitate the insertion of the flue on the articu-
22 lated joint 44 and changing flues as may be necessary
23 or desirable during surgery.

24 A ribbed flexible flue 49 is shown in Fig. 8
25 as including an axially elongated body portion 120
26 generally defined in cross-section with a circular
27 annulus and defining on the interior thereof a plural-
28 ity of spaced ribs 121 on the interior surface of the
29 body portion 120 along a predetermined length
30 thereof. Fig. 9 illustrates an embodiment in which
31 three such inwardly projecting ribs 121 are used, each
32 located 120 degrees apart on the circumference of the
33 bore. At its inward end, the flexible flue 49 is
34 defined by a radially outwardly extending portion 123
35 which merges into an angular portion 124 which further
36 merges into the wall of the body 120. The ribs provide

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1 structural rigidity to the flexible flue 49 while per-
2 mitting its flexure to accommodate curved tips and to
3 permit easy centering of the flexible flue 49 about the
4 tip 34 located therein, as in the alternative embodi-
5 ment. A typical taper is on the order of 2 degrees and
6 the angled portion 124 may be oriented relative to the
7 radially outwardly extending portion 123 at an angle of
8 about 45 degrees. In the alternative, only a single
9 rib, which is preferably a spiral, may be used, or more
10 than three ribs, such as six ribs located 60 degrees
11 apart, may be used. Fig. 9 illustrates a cross-section
12 of the flexible flue 49 taken near its outward end 126,
13 while Fig. 10 shows a cross-section taken at about the
14 location in the interior of the flexible flue 49 where
15 the ribs 20 terminate so that the portion 127 is free
16 from such interior ribs.

17 Figs. 11-15 together illustrate the nosecone
18 extension 42 shown in the embodiment of Fig. 2. As
19 described, the nosecone extension 42 is characterized
20 as providing a rotating joint 43 at its inward or rear-
21 ward end, and an articulating joint 44 at its outward
22 or forward end. The nosecone extension 42 is defined
23 by a body 140 which includes a generally cylindrical
24 portion 141 and an integral tapered conical portion 142
25 which tapers to its maximum diameter at its inboard end
26 143. The nosecone extension is preferably made from a
27 suitable medical grade plastic such as polycarbonate.
28 The area in which the tapered portion 142 merges into
29 the generally cylindrical portion 141 is defined by a
30 gentle recess 143. Outwardly of the portion 141 is
31 formed a generally circular cross-sectioned articula-
32 ting joint having a recess 146 between circular
33 areas. The outward surfaces of the arcuate portions
34 144 and 145 of the articulating joint 44 lie on the
35 diameter of a circle having its center on the axis of
36 the nosecone extension 42. The diameter of the circle

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1 is sized to receive the inward end of either the ribbed
2 flexible flue 49 or the rigid flue 47 in a snap fit,
3 quick-connect relationship which is secure and leak-
4 proof.

5 At the inward end of the nosecone extension
6 42 as defined by the wall 143, a radially-inwardly
7 projecting seal 147 is provided in the form of a bead
8 or rim which is semi-circular in cross section as shown
9 in detail in Fig. 13. The bead or rim 147 acts as a
10 camming and locking member when the nosecone extension
11 is inserted onto the nosecone 42 so that the bead 147
12 rests in the recess 103 after camming along the surface
13 104 of the nosecone 33, as shown in Fig. 6.

14 An irrigation cowl is generally depicted by
15 the reference numeral 150 and defines an irrigation
16 opening through an angled bore 151 therein terminating
17 in an inlet irrigation port 152. The center line of
18 the generally cylindrical irrigation bore 151, for the
19 passage of irrigation fluid into the nosecone extension
20 42, lies at an angle relative to the axis of the nose-
21 cone extension 42 so that the bore 151 defines an
22 elliptical opening 153 in the outwardly descending-
23 diameter interior bore of the wall portion 142, as best
24 seen in the side view of Fig. 15. The irrigation cowl
25 150 includes a wall body portion 153 having an irreg-
26 ular contour 154 as shown in Figs. 11, 13 and 14 to
27 merge attractively with the nosecone extension 42.
28 Such a nosecone extension 42 is convenient as providing
29 a quick connection to the nosecone 33 itself at its
30 inlet end by a mere snap fit coaction wherein the bead
31 147 cams on the outward surface of the nosecone 33 and
32 snap fits into the recess 103 of the nosecone 33 with a
33 tactile indication which may also be heard by the
34 assembler. In addition, such an arrangement permits
35 rotation of the nosecone extension 42 about the nose-
36 cone 33 to orient the irrigation cowl 150 and hence the

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1 irrigation inlet opening 152 to a convenient circumfer-
2 ential location for connection of the irrigation tube
3 89 (see Fig. 5).

4 Similarly, the outlet end of the nosecone
5 extension 42 provides a convenient quick connection for
6 a flue 47, 49 which not only permits articulation of
7 the flue to orient the outlet of the flue in a parti-
8 cular direction relative to the axis of the nosecone,
9 but also to center the flue around the tip therein,
10 thus to accomodate tips of alternate shapes. The
11 cooperating structure between the inlet of the flue and
12 the outlet of the nosecone permits rotation of the flue
13 thereabout and a tactile indication that the flue is
14 properly seated upon the outlet of the nosecone exten-
15 sion.

16 Figs. 16 and 17 illustrate a nosecone exten-
17 sion adapter 57 for use with an extender sheath 60 when
18 a curved elongated tip 54a and an associated extender
19 56 are used, as shown in Fig. 3. With respect to the
20 inlet end of the nosecone adapter 57, its components
21 are similar to the inlet components of the nosecone
22 extension 42 described in connection with Figs. 12-
23 15. Thus, like reference numerals are utilized. Its
24 outlet end differs, however, to provide a quick connec-
25 tion to an extender sheath 60. Thus, the portion 140
26 merges into a second cylindrical portion 170 defined in
27 cross section by an annulus and extending outwardly
28 from the wall portion 140 to define at its outermost
29 surface an outwardly-flared portion 171, shown in
30 detail in Fig. 17. The inside diameter of the out-
31 wardly-flared portion 171 is defined by an outwardly
32 tapering surface 172 while the outside diameter of the
33 flared portion terminates in an apex 173 having a rela-
34 tive maximum diameter. The structure thus permits an
35 extender sheath 60 to be slip fit over the outward end
36 of the nosecone extension adapter and secured therein

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1 in a slip fit relation to an extent limited by the
2 shoulder 170a. The apex 73 provides resistance to
3 withdrawal of the extender sheath from the nosecone
4 extension adapter 57 while the tapered portion 171
5 permits a camming action of the extender sheath thereon
6 during the insertion process to facilitate assembly.
7 Otherwise, the elements of the nosecone extension adap-
8 ter 57 are like those shown for the nosecone extension
9 42 and cooperate in the same manner.

10 The articulating joint which was omitted from
11 the nosecone extension adapter 57 is included on the
12 outlet of the flue adapter 67 shown in Figs. 18-21.
13 Thus, the flue extender adapter is structured to be
14 inserted into an end of the extender sheath 60 opposite
15 to that which receives the outlet end of the nosecone
16 extension adapter. The articulating joint 70 of the
17 flue adapter 67 is structured like the articulating
18 joint on the nosecone extension 42 and thus need not be
19 described in greater detail. The flue adapter 67 is
20 defined by a body portion 180 having an inlet cylin-
21 drical portion 181 defining at its inlet end 182 an
22 apex 183 structured similarly to the outlet configura-
23 tion of the nosecone extension 57. Thus, like refer-
24 ence numerals are used.

25 The cylindrical portion 181 merges into a
26 thickened outward wall portion 82 which tapers down-
27 wardly toward the outlet end of the flue adapter 67 to
28 define the articulating joint 70. At the area of
29 merger between the thickened wall portion 182 and the
30 cylindrical wall portion 181, a radially inwardly
31 directed wall portion 184 is included, as best seen in
32 cross section in Fig. 21. The interiorly-directed wall
33 portion 184 thus defines a plurality of spaced semi-
34 circular portions 185 equally spaced about the circum-
35 ference of that wall portion to provide water passage
36 through the structure. Preferably, the flue adapter is

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1 made from a suitable medical grade plastic such as
2 polycarbonate.

3 Returning to the embodiment of Figs. 2, 3,
4 and 5, an irrigation fitting 78, shown in Figs. 22 and
5 23, is utilized. The irrigation fitting 78 has an
6 outlet end which is slip fit into the irrigation port
7 on either the adapter or on the nosecone extension 42
8 and has its inlet end suitably structured for receiving
9 thin-walled tubing thereon. Fig. 22 thus shows a cross
10 section of the irrigation fitting 78 having a tapered
11 outlet wall portion 191, a central upwardly raised
12 portion 192 terminating in an inlet wall portion 193
13 having a radially outwardly extending barb 194 for
14 securing the irrigation tubing 89 thereon. The taper
15 of the outlet wall portion 191 facilitates its inser-
16 tion into the irrigation port 79, while the barb 194
17 resists withdrawal of the irrigation tubing 89 from the
18 fitting 78. The central upraised wall portion 192
19 provides a suitable bi-directional barrier against
20 overinsertion of the irrigation fitting 78 into the
21 irrigation port 79 and a suitable stop for the end of
22 the irrigation tubing 89 when assembled as indicated
23 diagrammatically in Fig. 4. In practice, the fitting
24 has its outlet end 191 cold bent as seen in Fig. 23
25 after turning to a suitable angle, such as about 24
26 degrees, so that the fitting 190 can be inserted into
27 the irrigation tube 89 and thus inserted into the irri-
28 gation port having a correct angular orientation to
29 direct the irrigation tube outwardly and parallel rela-
30 tive to the body of the nosecone extension to the out-
31 side of the aspiration tubulation connector, as well as
32 parallel to the body of the handpiece 31. The irriga-
33 tion tubing may also be secured by clips.

34 The aspiration tubulation connector 71 is
35 shown in contour in Fig. 24 as defining an outward port
36 75 for mating with the aspiration port 37 on the tip 34

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1 and an inward port 202 for receiving an end of the
2 aspiration tube 76 in a secure relationship. The
3 aspiration tubulation connector 71 further includes a
4 fluid passage between the inward port 202 and the out-
5 ward port 75 through the exterior body portion 72, the
6 fitting portion 73 and the transition portion 74. As
7 can be seen from Figs. 3 and 4, when the aspiration
8 tubulation connector 71 is snap fit into place within
9 the nosecone extension, its snap fit portion 73 is
10 rigidly secured within the slot 40, 41 defined in the
11 nosecone 33. Similarly, its outwardly extending body
12 portion 72 lies along the outside wall of the handpiece
13 so that its inward port 202 is axially directed to
14 accomodate the aspiration tube 76 along the exterior of
15 the handpiece as shown in Fig. 4.

16 Preferably, the aspiration tubulation
17 connector 71 is made of a left side component shown in
18 Figs. 25A through 25F and a mating right side component
19 as shown in Figs. 27A through 27F. The left side
20 portion and the right side portion are thus joined
21 together by mating male members 207 in the left side
22 component with female openings 208 on the right side
23 component. The inward portion 202 is tapered so that
24 the aspiration tubing readily slides thereon to a
25 shoulder 210 defined adjacent the portion 204. The
26 interior passage between the inlet 202 and the outlet
27 201 is designated generally by the reference numeral
28 212 and is thus shown in either of Figs. 25 and 27.
29 The inward port 202 defines an outwardly tapered inlet
30 portion 212 in the outermost wall of the outlet portion
31 213 to permit easy envelopment of the aspiration port
32 on the tip. Preferably, the aspiration tubulation
33 connector is made from a suitable medical grade
34 material such as polycarbonate. The operation of the
35 tubulation connector has been described in connection

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1 with Figs. 3 and 4 and the connector is structured so
2 as to permit ready and easy connection as described.

3 Fig. 28 shows a seal 300 in cross-section for
4 providing a quick, positive, uncomplicated connection
5 by a one-way valve (not shown) to a tissue release port
6 on a console, as shown in Fig. 5. The outward end 302
7 receives a vacuum tubing end in a slip fit relation-
8 ship. The seal 300 includes a irregularly-shaped wall
9 304 having a plurality of protrusion 306 for a slip fit
10 connection to a T-valve assembly 308 shown in Fig. 5,
11 by insertion of a tip 310 prior to the T-valve
12 assembly. The protrusion 306 and in manipulating that
13 insertion. The seal 300 thus provides an effective
14 connector for tubing otherwise directly connected to
15 the T-valve assembly 308.

16 The invention may be embodied in other speci-
17 fic forms without departing from its spirit or
18 essential characteristics. The present embodiments
19 are, therefore, to be considered in all respects as
20 illustrative and not restrictive, the scope of the
21 invention being indicated by the claims rather than by
22 the foregoing description and all changes which come
23 within the meaning and range of the equivalents of the
24 claims are therefore intended to be embraced therein.

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WHAT IS CLAIMED IS:

1 1. In an ultrasonic surgical system of the
2 type which comprises a handpiece which includes the
3 combination of an ultrasonically vibrating tip, a nose-
4 cone secured to a handle about said tip and means for
5 vibrating said tip, the improvement comprising:

6 a nosecone extension means defining at one
7 end thereof a rotating joint for connection to an out-
8 ward side of said nosecone and at a spaced end thereof
9 an articulating joint for connection to a flue envelop-
10 ing said tip

11 a rotating joint as described in conjunction
12 with resilient clips which provides an ergonomic and
13 independent positioning of irrigation and aspiration
14 ports on the surgical handpiece.

1 2. The combination as set forth in claim 1
2 wherein said nosecone extension means includes a body
3 defining at one end said articulating joint and at the
4 other end said rotating joint, said body further
5 defining an irrigation cowl having an irrigation port
6 for receiving an irrigation fitting therein.

1 3. The combination as set forth in claim 1
2 wherein said nosecone extension means includes a nose-
3 cone extension adapter defining at one end said
4 rotating joint and at its other end means for coopera-
5 ting with an extender sheath, said nosecone extension
6 means further including a flue adapter defining at its
7 outer end said articulating joint and at its inner end
8 means for cooperating with the other end of said
9 extender sheath so that said nosecone extension
10 adapter, said extender sheath, and said flue adapter
11 are combined to envelop an extender and a portion of
12 said tip, said nosecone extension adapter defining an
13 irrigation cowl having an irrigation port for receiving
14 an irrigation fitting thereon.

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1 4. The combination as set forth in claim 2
2 further including an irrigation tubing connector struc-
3 turally adapted for insertion at one end into said
4 irrigation port and at its other end for connection to
5 said irrigation tubing.

1 5. The combination as set forth in claim 3
2 further including an irrigation tubing connector struc-
3 turally adapted for insertion at one end into said
4 irrigation port and at its other end for connection to
5 said irrigation tubing.

1 6. The combination as set forth in claim 4
2 wherein said irrigation connector includes a tapered
3 generally cylindrical portion for insertion in said
4 irrigation port in said irrigation cowl of said nose-
5 cone extension means, a shoulder portion limiting the
6 insertion of said irrigation connector therein; and a
7 barbed cylindrical portion for receiving an end of said
8 irrigation tubing.

1 7. The combination as set forth in claim 5
2 wherein said irrigation connector includes a tapered
3 generally cylindrical portion for insertion in said
4 irrigation port in said irrigation cowl of said nose-
5 cone extension means, a shoulder portion limiting the
6 insertion of said irrigation connector therein; and a
7 barbed cylindrical portion for receiving an end of said
8 irrigation tubing.

1 8. The combination as set forth in claim 1
2 further including an aspiration tubulation connector
3 defining an inlet port for connection with an aspira-
4 tion port of said tip and an outlet port structurally
5 adapted for connection to aspiration tubing.

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1 9. The combination as set forth in claim 8
2 wherein said aspiration tubulation connector is further
3 defined in that the axis of its outward port is axially
4 offset from the axis of its inward port so that, when
5 connected, said aspiration tubing lies along the out-
6 side of the handle of said handpiece, said aspiration
7 tubulation connector further defining a passage from
8 said inward port to said outward port.

1 10. The combination as set forth in claim 9
2 wherein said aspiration tubulation connector includes a
3 transition portion structurally adapted to frictionally
4 engage a slot on said nosecone and said nosecone exten-
5 sion means, when assembled, so that when said transi-
6 tion portion is securely inserted in said slot, said
7 outward port engages the aspiration port of said tip
8 and said inward port lies along the outside of said
9 handpiece.

1 11. For use in an ultrasonic surgical aspir-
2 ation system of the type which includes a handle
3 assembly providing a source of ultrasonic vibrations to
4 a tip, and a nosecone secured to said handle for envel-
5 oping a connection between said tip and said vibration
6 source, a nosecone extension comprising:

7 a body comprising a first portion which
8 includes means for cooperating with said nosecone to
9 provide a rotating connection therewith and a bore
10 therethrough for passage of said ultrasonically vibra-
11 ting tip, said first portion merging into a second
12 portion which is generally cylindrical and defining at
13 its outer end an articulating joint structurally
14 adapted for receiving a portion of a flue thereon in an
15 articulating relationship.

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1 12. The nosecone extension as set forth in
2 claim 11 further including an irrigation cowl defining
3 an irrigation passage having an axis oblique to an axis
4 of said nosecone extension, said irrigation cowl
5 defining at its inward end an irrigation port struc-
6 turally adapted for receiving a fitting connected to
7 irrigation tubing.

1 13. The nosecone extension as set forth in
2 claim 12 wherein said first body portion defines an
3 inwardly extending semi-circular bead which circumfer-
4 entially extends about an inward end of said nosecone
5 extension for engaging a mating recess on said nose-
6 cone.

1 14. The nosecone extension as set forth in
2 claim 12 wherein said articulating joint is defined by
3 an arcuate portion having a diameter the center of
4 which lies on an axis of said nosecone extension and a
5 recess in said arcuate portion for receiving an O-ring
6 therein for articulately securing said flue thereon
7 in a fluid-tight relationship.

1 15. The nosecone extension as set forth in
2 claim 14 in further combination with a flue having an
3 elongated tapered body and defining a bore therein for
4 passing said tip therethrough and defining at its
5 inward end an arcuate portion having a contour which is
6 structurally complementary with the contour of said
7 articulating joint on said nosecone.

1 16. The nosecone extension as set forth in
2 claim 14 in further combination with a flexible flue
3 having an elongated body portion terminating at its
4 inward end in a radially extending flange for

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5 connection with said articulating joint in a fluid-
6 tight relationship.

1 17. The combination as set forth in claim 16
2 wherein said flexible flue includes an elongated body
3 defining a bore, said bore including at least one
4 axially extending rib for strengthening said body.

1 18. The combination as set forth in claim 16
2 wherein said flexible flue includes a plurality of
3 axially extending ribs spaced about the circumference
4 of the interior of said flexible flue.

1 19. The combination as set forth in claim 16
2 wherein said flexible flue is made from a plastic
3 material.

1 20. For use in an ultrasonic surgical system
2 of the type which includes the combination of a sub-
3 assembly of a handpiece, a nosecone, and a source of
4 ultrasonic vibration for an extended tip, with an elon-
5 gated extender enveloping a portion of said tip, the
6 combination comprising:

7 a nosecone extension adapter defining at its
8 inward end a rotating joint for connection with said
9 nosecone on said sub-assembly and an axially extending
10 circumferential portion for connection to an end of an
11 extender sheath structurally contoured to envelope said
12 extender and said tip, said nosecone extension adapter
13 defining an irrigation port.

1 21. The combination as set forth in claim 20
2 further including a flue adapter having an inward end
3 structurally adapted to connect with the outward end of
4 said extender sheath and defining at its outward end an
5 articulating joint for connection to a flue.

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1 22. For use in connection with a nosecone
2 adapter in an ultrasonic surgical system of the type
3 which includes an irrigation cowl defining an irriga-
4 tion fluid passage in an assembled handpiece of an
5 ultrasonic surgical system, an irrigation tubing con-
6 nector which includes an elongated body, said elongated
7 body defining an outward end portion structurally adap-
8 ted for insertion in said irrigation port;

9 a radially extending, centrally located rib
10 portion limiting the insertion of said first portion in
11 said irrigation port, and

12 a second axially extending tubular port for
13 insertion in a tubing end of irrigation tubing, the
14 insertion of said second end being limited by said
15 centrally located rib.

1 23. The irrigation tubing connector as set
2 forth in claim 22 wherein the end axis of said first
3 portion is oriented at an acute angle relative to the
4 axis of said second portion.

1 24. The irrigation connector as set forth in
2 claim 23 wherein said angle is about 24°.

1 25. The irrigation tubing connector as set
2 forth in claim 23 wherein said second portion includes
3 a circumferentially located barb tapered toward its
4 inward end to facilitate slip fitting of an end of said
5 irrigation tubing onto said irrigation connector and
6 inhibiting its withdrawal therefrom.

1 26. For use in combination with an ultra-
2 sonic surgical aspiration system of the type which
3 includes a handpiece which includes a source of ultra-
4 sonic vibrations, a nosecone, and an ultrasonically
5 vibrating tip having a portion connected to said source

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6 wherein said nosecone envelops at least a portion of
7 said tip, the improvement comprising means for defining
8 an irrigation manifold to provide a passage for irriga-
9 tion fluid from a source to a surgical site adjacent
10 the outward end of said surgical tip, said irrigation
11 manifold means including a member rotatably connected
12 to said nosecone and defining an irrigation passage
13 oblique to an axis of said tip, said irrigation passage
14 terminating in an irrigation port structurally adapted
15 for connection to irrigation tubing to provide a source
16 of irrigation fluid to the interior of said member,
17 said member defining at its outward port means for
18 quick connection to an end of a flue structurally
19 adapted to envelop a portion of said tip, said flue and
20 said member together defining an irrigation passage for
21 flow of irrigation fluid from the interior of said
22 member communicating with said source of irrigation
23 fluid through said irrigation port and in the space
24 defined by the outside of said tip and the interior of
25 said flue.

1 27. In combination with an assembly of an
2 ultrasonically vibrating tip having an aspiration port
3 at an end thereof and communicating with an aspiration
4 passage, said tip being connected to a source of ultra-
5 sonic vibrations in a handpiece in an ultrasonic
6 surgical aspiration system so that at least a portion
7 of said tip being enveloped by a nosecone having a slot
8 in register with a slot in said vibration source, said
9 slots in register exposing said aspiration port of said
10 tip when assembled to the exterior of said assembly,
11 the improvement comprising an aspiration tubulation
12 connector having an inlet port structurally adapted for
13 connection to aspiration port on said tip, an outlet
14 port structurally adapted for connection to aspiration
15 tubing at the exterior of said nosecone, said aspira-

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16 tion tubulation connector being structurally adapted to
17 define an aspiration fluid passage through said slots
18 in register from said inward port to said outward
19 port.

1 28. The aspiration tubulation connector as
2 set forth in claim 27 further including a transition
3 port structurally adapted to fit within said slot in a
4 secure relationship when said outward fitting is
5 secured to said aspiration port.

1 29. The aspiration tubulation connector as
2 set forth in claim 28 further characterized in that
3 said outlet port lie along an axis exterior to said
4 handpiece, said axis being axially offset relative to
5 the axis of said aspiration port on said tip and said
6 inlet port on said connector.

1 30. The combination as set forth in claim 8
2 further including a seal member for connection to a T-
3 valve assembly in said aspiration tubing, said seal
4 being structurally adapted for irrigation at one end
5 into said T-valve assembly and at its other end for
6 receiving tubing connected to a vacuum port on a
7 console.

1 31. The combination as set forth in claim 27
2 further including a seal member for connection to a T-
3 valve assembly in said aspiration tubing, said seal
4 being structurally adapted for irrigation at one end
5 into said T-valve assembly and at its other end for
6 receiving tubing connected to a vacuum port on a
7 console.

FIG. 1.
(PRIOR ART)

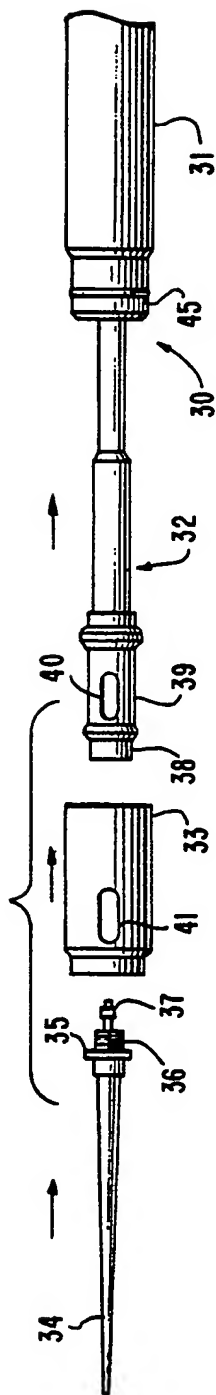


FIG. 2.

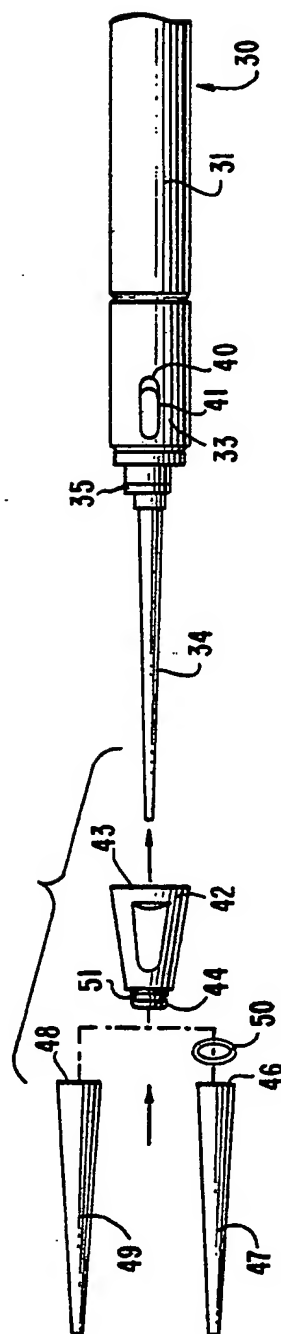


FIG. 3.

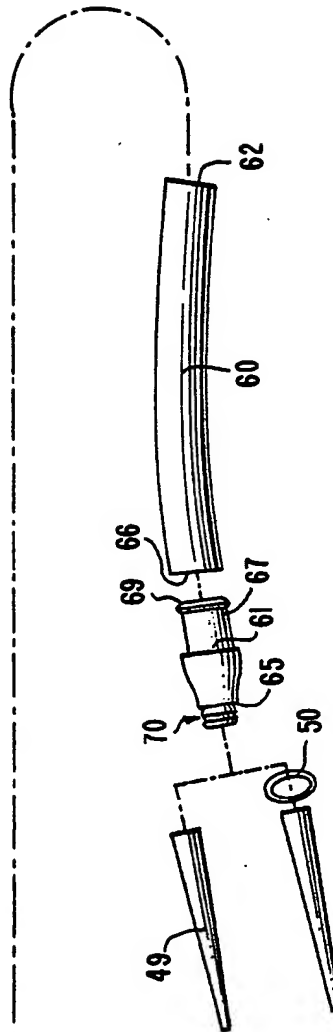
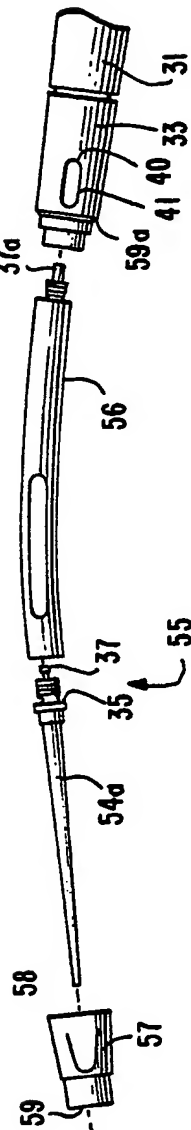


FIG. 4B.

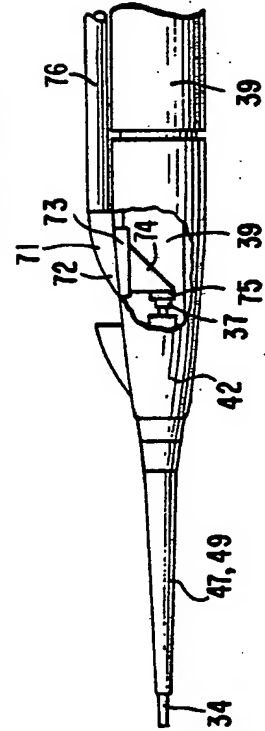
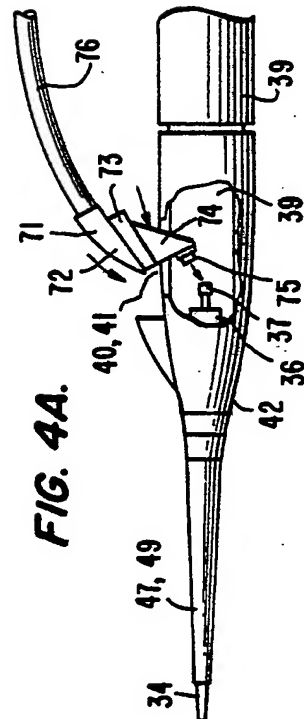
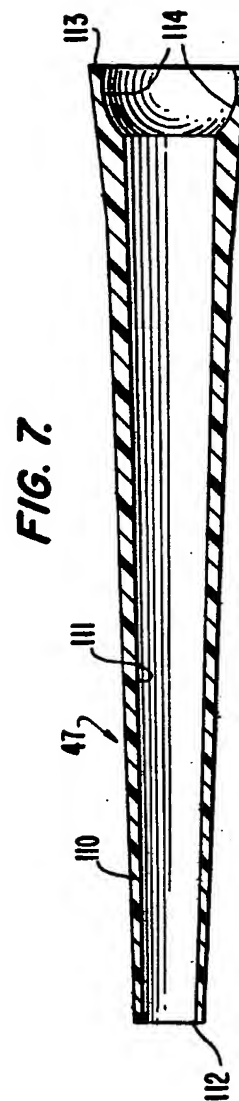
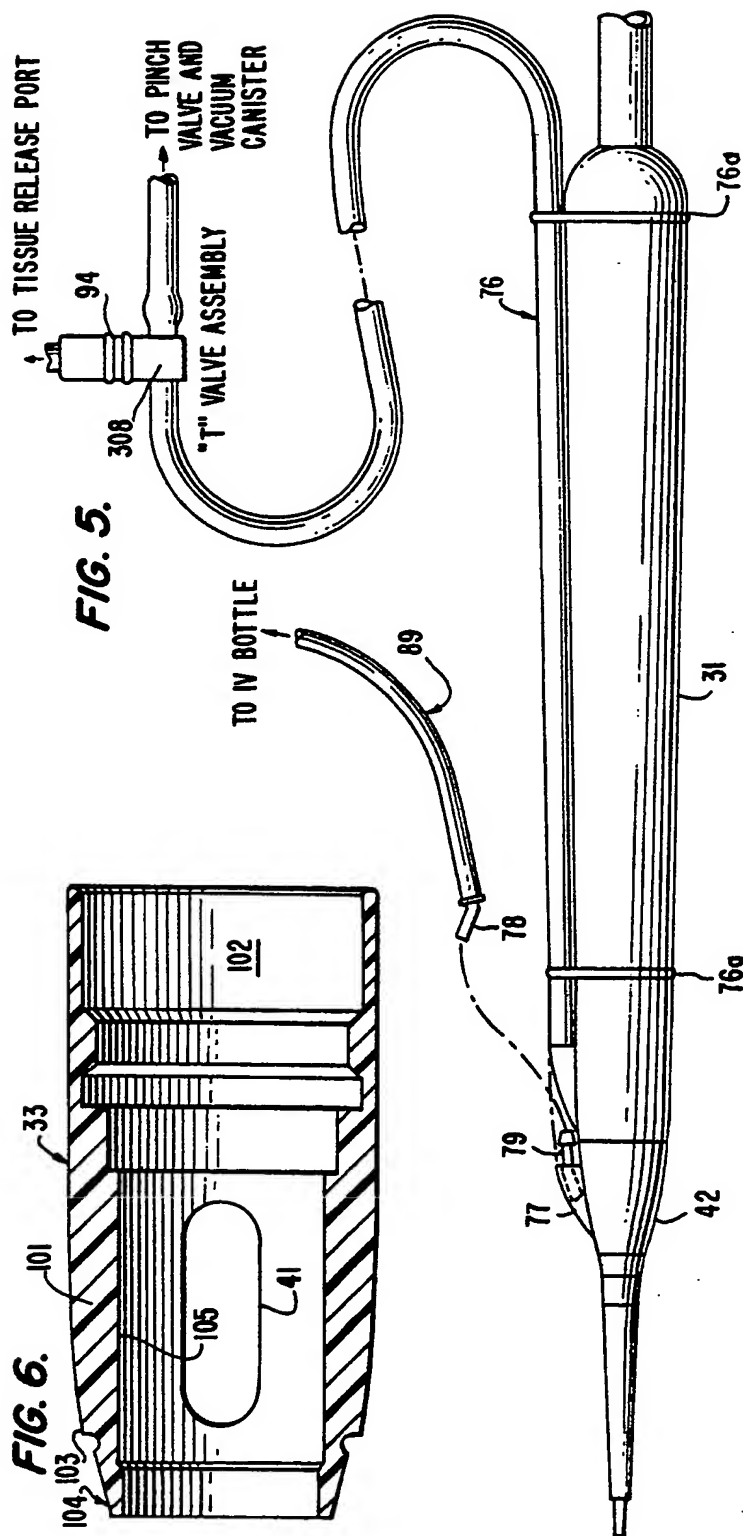


FIG. 4A.





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FIG. 8.

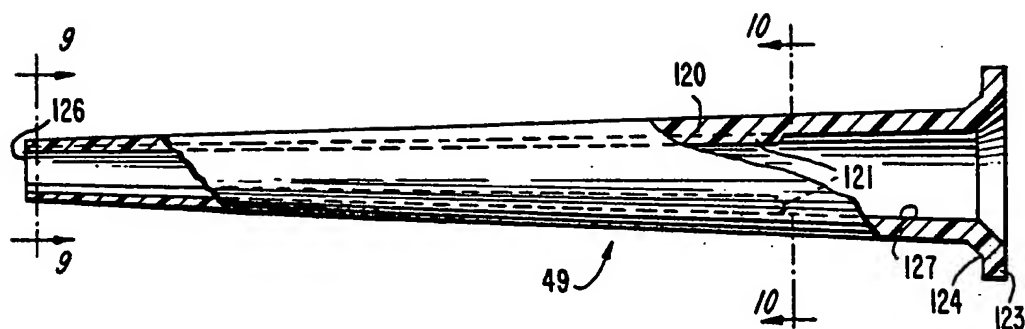


FIG. 9.

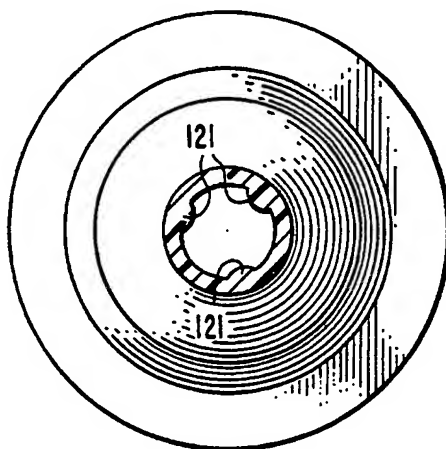


FIG. 10.



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FIG. 11.

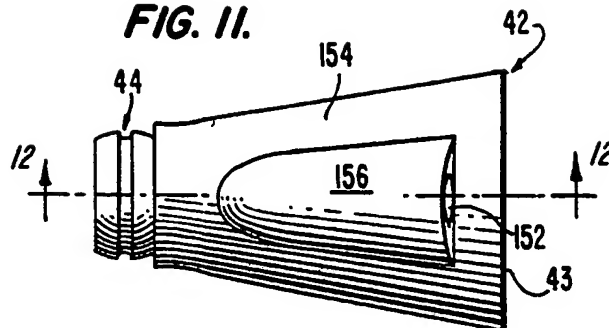


FIG. 12.

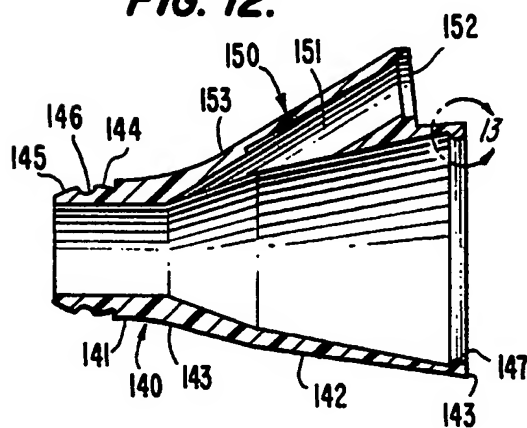


FIG. 14.

FIG. 13.

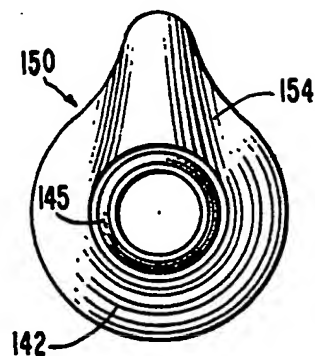
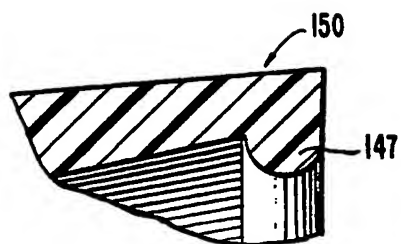


FIG. 15.

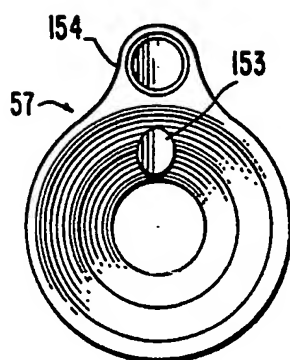


FIG. 16.

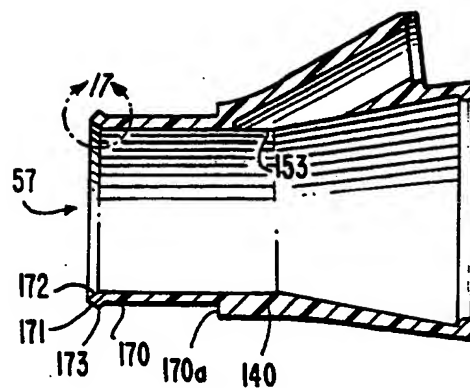


FIG. 17.

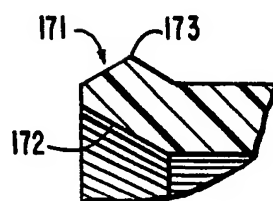


FIG. 18.

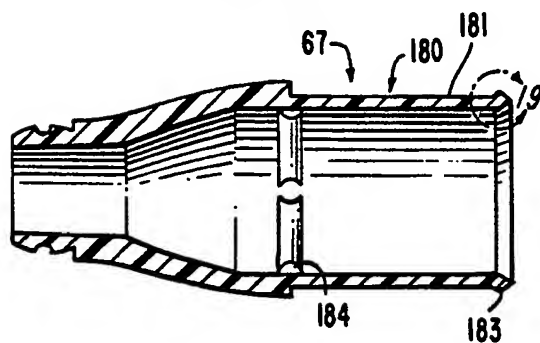


FIG. 19.

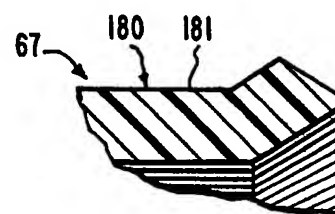


FIG. 20.

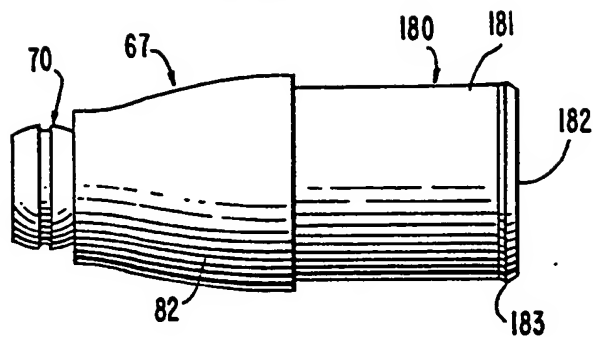


FIG. 21.

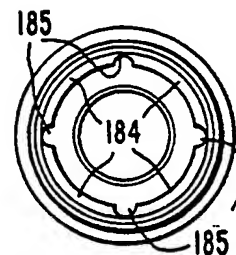


FIG. 22.

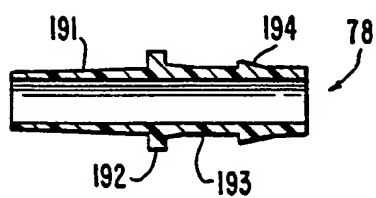


FIG. 23.

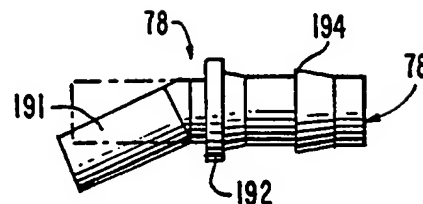


FIG. 24.

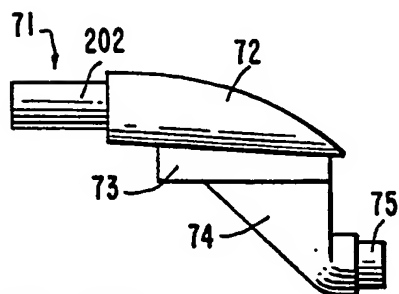


FIG. 25A.

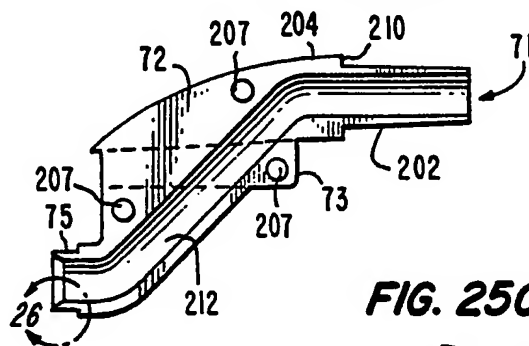


FIG. 25B.

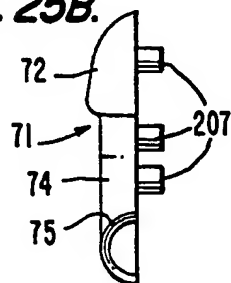
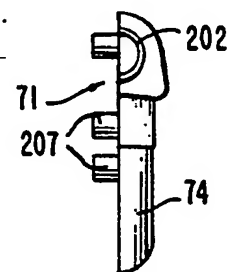
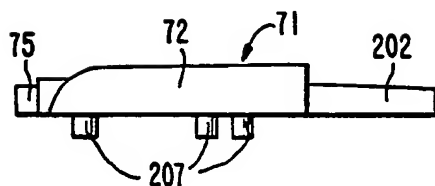
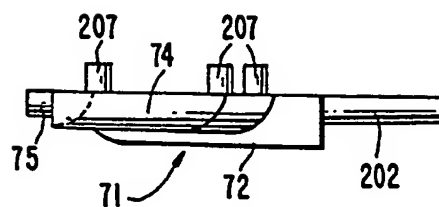
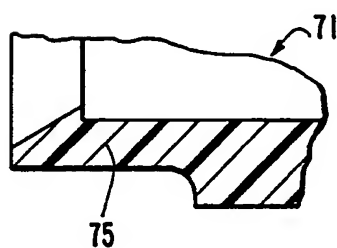
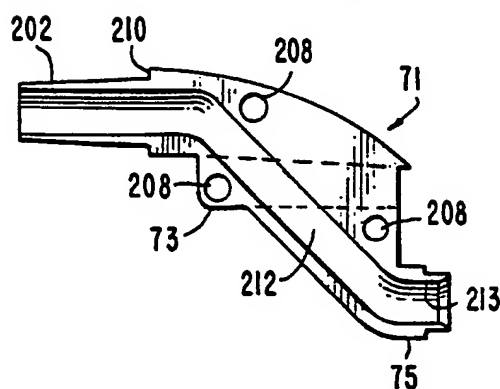
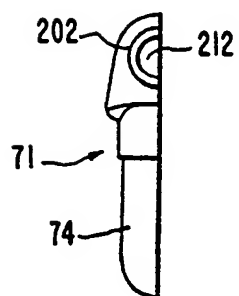
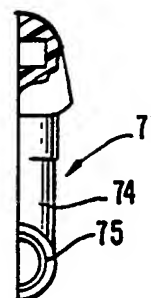


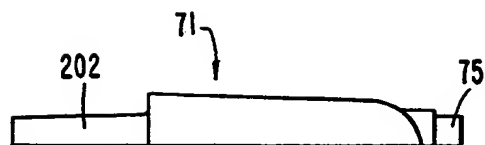
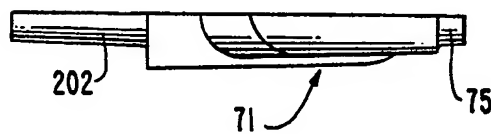
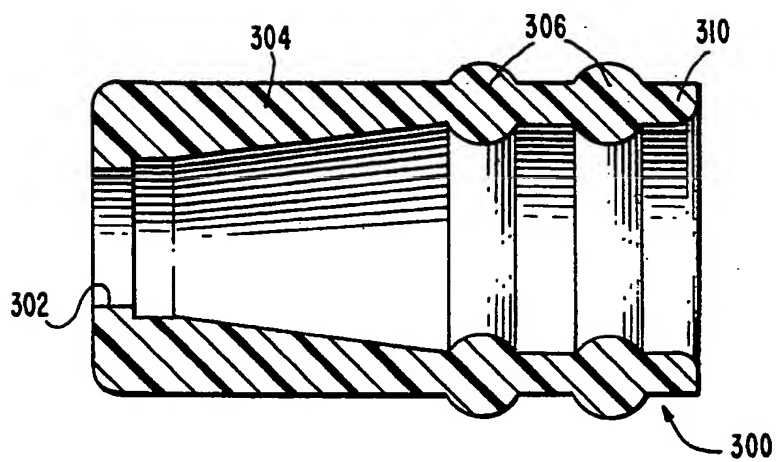
FIG. 25C.



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FIG. 25D.**FIG. 25E.****FIG. 26.****FIG. 27A.****FIG. 27B.****FIG. 27C.**

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FIG. 27D.**FIG. 27E.****FIG. 28.**

INTERNATIONAL SEARCH REPORT

International Application No.

PCT/US87/00795

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) ³		
According to International Patent Classification (IPC) or to both National Classification and IPC		
IPC (4): A61B 17/00		
U.S. Cl. 604/22, 35, 43, 283; 128/24A		
II. FIELDS SEARCHED		
Minimum Documentation Searched ⁴		
Classification System	Classification Symbols	
U.S.	604/22, 35, 39, 40, 43, 198, 283; 188/24A, 303	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched ⁴		
III. DOCUMENTS CONSIDERED TO BE RELEVANT ¹⁴		
Category ⁶	Citation of Document, ¹⁶ with indication, where appropriate, of the relevant passages ¹⁷	Relevant to Claim No. ¹⁸
X Y	US, A, 4,063,557 (WUCHINICH ET AL) 20 December 1977, see the entire document.	20 27
A	US, A, 3,589,363 (BANKO) 29 June 1971 See the entire document.	
A	US, A, 4,223,676 (WUCHINICH ET AL) 23 September 1980, see the entire document.	
A	US, A, 4,246,902 (MARTINEZ) 27 January 1981 See the entire document.	
A	US, A, 4,508,532 (DREWS ET AL) 02 April 1985, see the entire document.	
<p>¹⁵ Special categories of cited documents:</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"Δ" document member of the same patent family</p>		
IV. CERTIFICATION		
Date of the Actual Completion of the International Search ¹⁹	Date of Mailing of this International Search Report ²⁰	
01 June 1987	29 JUN 1987	
International Searching Authority ²¹	Signature of Authorized Officer ²²	
ISA/US	S.C. Pellegrino <i>[Signature]</i>	